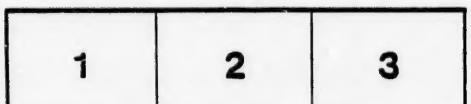

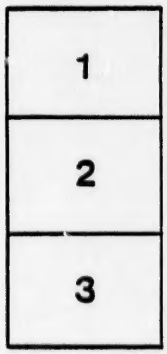

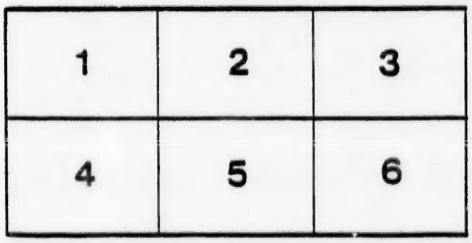

GEOLOGY OF ERIE CANAL

SALINA MARLYTES
AND RECENT IMPROVEMENTS.

BY DR. M. A. VEEDER,
OF LYONS, N. Y.

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GEOLOGY OF ERIE CANAL

SALINA MARLYTES AND RECENT IMPROVEMENTS. HUNDRDEDS OF THOUSANDS OF DOLLARS INVOLVED

BY M. A. VEEDER, M. D.

LYONS, N. Y.

The mode of formation of the basin of the Great Lakes has an important bearing upon proper understanding of the problem of the Erie canal in all its details. The agencies concerned in determining the topographical features involved, have no counterpart elsewhere in the world, at least not on any such scale of magnitude. Their very exceptional character has caused them to be misunderstood, and consequently their discussion needs to be very comprehensive.

Fortunately the successive steps by which the North American continent was built up, and its lakes and waterways excavated, are exhibited most magnificently in the geological formations in the vicinity of these lakes. The surroundings of this locality were such that the successive layers of material deposited about the growing continent were of conspicuous character, and have been well preserved with all their markings until the present time. Thus within the borders of the State of New York alone there is, as it were, an epitome of geological history so complete that it has become the standard for comparison throughout the world.

The location of the Great Lakes, with their associated drainage system and waterways, is determined primarily by the nature of underlying rock formations. The continent grew about the Adirondack region, as a nucleus, the strata in general sloping gently away from that center, as beaches slope from an island in the sea. Subsequently the land surface thus exposed was cut across by drainage channels, and finally was sculptured into its present shape by processes of weathering and erosion, the softer rock yielding first, and thus determining the situation of depressions and channels to be occupied by streams and lakes and as highways of commerce.

Especially important in the case of the

Great Lakes thus formed, is the evidence of ice action on an enormous scale in their vicinity. There must have been a time when the climate of this part of the earth was colder than at present. The immediate effect of such increase of cold would be to block the outlets of these lakes with heavy ice at certain seasons, and perhaps continuously for years in succession, causing the water to overspread the land adjacent. The soil thus reduced to the condition of plastic mud would be in a condition to be readily torn up, and ridged, and furrowed by ice fields driven upon it by wind and current, and the rise of the waters. If an obstruction of this sort at the outlet of one of the upper lakes, as for example that of Lake Superior, should give way suddenly, thousands of square miles of ice fields, borne along in a huge flood, would be precipitated at once into the basins of the lower lakes with tremendous effect. The hydraulic pressures and energy of movement developed under such conditions, would be fully adequate to account for the ice and water markings at different levels in the lake region, that have heretofore been ascribed to ordinary glacial action, or to changes of level of the geological strata themselves, instead of that of the waters. These effects of ice accumulation in the waters of the lakes would be intensified and extended by the coincident increase of snowfall on the land adjacent that would ensue. In the very nature of the case this sort of combined ice and water action must have occurred in this region as nowhere else in the world. The basin of these lakes being of immense size, and their outlets narrow, and their waters fresh and easily frozen, and their latitude such that increase of cold might readily occur, the conditions are perfect for such action, and as a matter of fact evidences of it appear everywhere in the area in question, and in the valleys that would become accessible through ice accumulation and rise of the waters.

From the point of view that has been indicated the peculiarities of the drainage system, and waterways of New York State, become clearly explicable. Southward from Lake Ontario there is a succession of terraces of rock rising step by step, as low cliffs or ledges, extending east and west across the State. The loose debris on the surface exhibits forms of arrangement that would result from the thrust of floating ice fields finding their way through valleys, or propelled against shore lines by prevailing winds. But the underlying resistant rock remaining in firm ledges is channelled along the lines where the material was softer, or in a direction parallel to Lake Ontario, which was excavated in like manner. Thus the outlets of Cayuga and Seneca Lakes, which originally ran northward, now run eastward, because of the removal of a stratum of softer material by ice action in the manner described. Thus, likewise, the Erie canal was made possible, the channel which it occupies being a topographical feature so conspicuous that it was noted by the Indians, the five nations living in its vicinity being known as the Iroquois, which signifies the "House of the Long Hall," referring to this natural avenue between the seaboard and lake region.

From the head waters of the Mohawk eastward the location of the channel oc

cupied by the canal depends very largely upon the physical peculiarities of the slates of the Utica and Hudson river groups. These consist of material that disintegrates into particles so small as to be readily suspended in water, giving it a very persistent milky appearance. The erosion of rocks of this formation is very rapid in water though not in air, they being reduced to an impalpable powder and thus floated away and deposited elsewhere in the form of fine clays such as are so abundant in the Mohawk and Hudson valleys. It was the presence of an abundance of material of this variety, of different geological epochs, together with a large flow of water, that brought about the excavation of Lakes Erie and Ontario. With a smaller flow of water, and consequently on a smaller scale, Seneca and Cayuga Lakes were eroded in like manner in material of this same species. As it exists in the Mohawk and Hudson valleys this material does not present any serious difficulties of classification from an engineering point of view.

From the head waters of the Mohawk westward for a hundred miles, or more, the case is different. The location of this portion of the canal is determined by the red and blue shales of the Salina Period, a formation having peculiarities probably not encountered in engineering work on any such scale in the whole world. The material looks like red and blue clay of modern origin, but is nothing of the sort. It belongs to a very ancient period of geological history, and was compacted through long ages under superimposed strata that have since been swept away by ice and lake action, leaving the portions traversed by the canal nearly bare. The undisturbed layers thus compressed are much harder than any clay, although broken fragments lying loose on the surface disintegrate readily. Unlike clay, it contains much lime, and hence is technically known as marlyte. The presence of this lime gives it much firmer consistency when compacted in ledges, and on the other hand causes it to slack and disintegrate more readily in detached fragments. The peculiar nature of this formation is still further shown by the fact that it is everywhere associated with the presence of salt, the chief brine wells and salt deposits in the United States, having commercial value, being located in it. Certain layers of these shales also are the chief source of gypsum and land plaster. Large and beautifully transparent crystals of selenite, a very pure form of gypsum, were found in a cutting made by the West Shore railroad in these red and blue marlytes about three miles west of the village of Lyons. From this it is apparent that the chemical nature of these shales is very unusual, sulphur, lime, silicate of alumina and common salt entering into their composition in varying degrees. It would appear that volcanic action must have been concerned to some extent in bringing about such a mixture containing sulphur Indeed, near Syracuse, where this formation reaches its largest and most typical development, the Green Lakes at Manlius and Jamesville appear to be the remnants of true craters, like the Green lakes of Madagascar, which are plainly associated with evidences of volcanic action. Other indications of igneous action have been

found in the rock at DeWitt, east of Syracuse, recently. The outflow of natural gas in the region immediately southeast of Lake Ontario appears to be associated with these deep seated activities of a volcanic nature. From all this it is evident that the canal traversing these formations meets with a set of conditions of very exceptional character, and that are of great importance from an engineering point of view.

The Salina marlytes and shales, the line of whose outcrop the canal follows, very nearly from Rome to Rochester, are flanked on the north and south by ledges of very solid and durable limestone, known as the Niagara, and Corniferous, respectively. The weathering and erosion of this softer material interposed between these lines of very hard rock, has changed the entire drainage system of this part of Western New York, thus putting the canal in the precise position it occupies. The streams instead of flowing directly north into Lake Ontario, as the outlets of Seneca and Cayuga Lakes once did at Sodus Bay, now turn eastward, and make a long detour before reaching the lake at Oswego. This trough-like depression excavated in rock determines the direction of drainage, although it contains much superficial debris which has been erected into curious parallel hills that are thickly set over many hundreds of square miles, especially in Wayne and Cayuga counties. This material, of which these hills are composed, is derived almost exclusively from the Salina shales and marlytes, to whose outcrop they are very strictly confined. These hills look like mud, containing many scratched and polished stones and boulders, compacted into a very tough and refractory hardpan, by ice and lake action of the type that has been indicated. It is troublesome material to excavate, but not so bad as the undisturbed marlyte ledges from which it is derived.

These ledges superficially give but little indication of their true character, and might very readily be mistaken for clay banks, or banks of the hardpan just mentioned. When rounded off by the wash of rains they may even look like piles of ordinary earth. On opening up their interior, however, it is found that there is no tendency to crumble, or scale off, nor are there any seams, or joints of cleavage, the entire mass being cohesive, like dried putty, but of much firmer consistency. Blasting, or wedging, makes but little impression, there being no seams to open up, and the disintegration by the jarring of the explosion, or wedging, extends but two or three inches as a rule. Even the narrowest form of plough is very ineffective in tearing up this sort of material.

There are many indications that the exceptional character of this part of the Salina formation is not duly appreciated. For example the Garbage Disposal Works for the city of Rochester were placed upon it at Macedon, creating a nuisance, largely because of its imperviousness, compelling their abandonment at a loss of many thousands of dollars. There is a similar proposition in regard to the location of a sewage farm at Lyons that will surely result in failure, unless the nature and location of this material is taken into the account.

Especially in connection with the recent nine million canal improvement is

the anomalous character of this material brought out most clearly. There was re-classification and re-rating during the progress of the work to the extent of hundreds of thousands of dollars, the natural consequence being much newspaper discussion, and legislative inquiry. Experts, apparently on very cursory examination, and without a full understanding of the points involved, have differed greatly in their estimates as to the nature of the material, and the expense of excavation. The railroad companies have had this same difficulty in classifying and rating the prices for excavation of this material, contractors threatening to abandon their contracts when they became aware of its true nature.

In view of these disagreements, and of the popular misapprehensions arising, and because it is a question that concerns the future of the canal, as well as its past history, the writer, some weeks since, addressed the following letter to State Engineer Adams:

"In the discussions in regard to the canal question there is a point that ought to have been made more clear to the popular understanding, and that it is certain would have saved a great deal of difficulty all around. It is in reference to the relation which the canal holds to the outcrop of the shales of the Salina Period, technically known as marlytes. This is a very ancient formation having peculiarities possessed by no other, except it be small portions of the strata of the Clinton. Superficially the red and blue shales of this period look like rather soft clay, and in broken fragments readily disintegrate in air or water, but they are not clay, and for the most part consist of material that is as difficult or more difficult of excavation than hard rock. Containing lime mixed with silicate of alumina, and other ingredients, their composition is such that they cannot be blasted successfully, nor can they be torn up by any ordinary plough. In the text books on Geology they are classified as rock, and should have been classified as rock in the specifications for the contracts. But they look so very different from any ordinary species of rock that there might very well be room for honest differences of opinion, and putting them in, as was done at the outset, as earth was taking the safe side so far as protecting the interests of the State was concerned. As the matter stands it seems as though the peculiarities of these shales ought to be made better known, not only as explaining the difficulties that have arisen but likewise those that are likely to arise hereafter."

Mr. Adams, reply was as follows:

"I have read your letter of Dec. 9th with very great satisfaction. Professor Clarke, acting State Geologist, sustains your position in conversation with me. The ideas you express are in exact accordance with what we observed during the prosecution of the canal work. The appearance of the material before being excavated, and its consistency, or condition, upon exposure, in many instances were markedly different, so that an inspection a few months, or a year after the examination had taken place, did not reveal the original condition by any means.

"I am glad that you perceived that our Engineers, acting under direction, took the safe side in reporting for estimate the ma-

terial excavated as earth, which was the lowest priced material, until their superiors could properly classify it. We acted thus as we believed at that time, and as we believe this minute, for the best interest of the State."

The following letter, upon the subject of the Salina marlytes, has also been received by the writer from the Resident Engineer of the Western Division, C. R. Neher of Rochester:

"At the request of the State Engineer, I take pleasure in giving you such facts relative to the shales met with in the canal improvement, as came within the scope of my observation, treating them strictly from the standpoint of their relatively higher cost to excavate than earth.

"The records on file in this office, of the canal enlargement for the years 1857 and 1858, indicate that the Engineers recognized the shale as being more difficult to excavate than ordinary earth, and classified it under the head of rock of two different grades.

"1st—'Quarried Rock,' 'material which, in the opinion of the Resident Engineer, can be excavated without blasting.' 2d—'Solid Rock,' 'material which, in the opinion of the Resident Engineer, cannot be excavated without blasting.'

"By comparing the locations where these classifications prevailed, it is shown that it included these shales, as localities are included in the estimates where no true ledge rock existed, and there was large quantities of shale. The relative prices paid for shale classified as 'Rock' was on an average as follows: 'Quarried Rock' double the price paid for 'Earth Excavation,' and for 'Solid Rock' from three to four times the price paid for earth excavation. I am of the opinion that these relative prices truly represent the comparative cost of excavating.

"The specifications for the 'Nine Million Improvement' made no specific provision for classifying shales, only as included under the general head of 'Rock,' as 'All solid or ledge rock and hardpan which, in the opinion of the Resident Engineer, cannot be plowed.' This necessarily excluded large amounts of the shales from a Rock classification, the partially disintegrated shales being classed as 'Earth,' although costing relatively more than true earth. From a large collection of data in my possession I obtain the following average yardage excavated per day per man:

"Shales that cannot be ploughed 3.74 cubic yards. True ledge rock, as Medina sandstone, 3 53 cubic yards This yardage per day per man does not include all the expense of excavating, as there was added to the expense for laborers the cost of explosives, and McMyler derricks costing to operate $24.50 per day for a gang of 40 men, these averages being used to demonstrate simply that the cost of excavating shales is relatively the same as for rock, as the comparisons were always made with the same gangs of men and the same plant operating separately in shale and rock.

"In general, better results were obtained by explosives in ledge rock than in shales, the ledge rock opening along the dividing line of the strata and leaving a level bottom, while the shales blew out in pockets, leaving ridges above grade between the shots which had to be worked

down with picks, a tedious and expensive process. The distance holes had to be drilled below grade to give best results, and was about the same in rock as shale and averaged one foot.

"The rapidity of the disintegration of these shales when exposed was a notable characteristic, being very noticeable in 24 hours, and in some cases, where it was taken out in large blocks and deposited in spoil banks became a pasty mass in a couple of months.

"It is evident that there is a lack of knowledge as to the true nature of these shales, as evidenced by adverse criticism of the classification under the Nine Million Improvement, even Engineers having testified before the Canal Investigating Commission that in their opinion, based on viewing spoil banks, that the material classified as 'Rock' was improperly classified.

"I take pleasure in furnishing you this data, if it will tend to give tardy justice to those Engineers who, as servants of the State, gave their best efforts to deal fairly and honestly with the State and Contractor, and in so doing have been held up as violating the trust imposed upon them."

So far as the present writer is concerned the sole purpose of this discussion, and of adducing the above correspondence, is to bring to popular notice the difficulties and importance of the subject, so that whatever may be done hereafter may be with a better knowledge of the material facts in the case.

LYONS, N. Y., Jan. 6th, 1899.